The Eastasouth Journal of Social Science and Humanities
Vol. 2, No. 03, June 2025, pp. 544 – 554
ISSN: 3026-5592, DOI: 10.58812/esssh.v2i03

Strategy For Developing an Artificial Intelligence (Ai)-Based Air Defense Integrated System (ADIS) To Realize a Strong National Air Defense

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Article Info

Article history:

Received Jun, 202x
Revised Jun, 202x
Accepted Jun, 202x

Keywords:

ADIS;
AI;
Development Strategy;
National Air Defense

ABSTRACT

This study discusses the Strategy for Developing an Air Defense Integrated System (ADIS) based on Artificial Intelligence (AI) in realizing a strong national air defense. The purpose of this study is to analyze the capabilities of ADIS, the use of AI technology and its development strategy in supporting the realization of a strong national air defense system. The method used is SSM analysis as the main method, the supporting method applied is Analytical Hierarchy Process (AHP). The results of the study indicate that the AI-based ADIS development strategy is an ecosystem model that can realize a solid, strong, independent, and sovereign air defense system, which is in accordance with the structure and characteristics of the Indonesian nation as an archipelagic country. The strategy for developing a strong air defense includes the formation of the National Air Defense System Posture (Sishanudnas) and System Integration, human resources (HR) in line with effective airspace management, accompanied by a doctrine that is able to adapt to the demands of technological progress and changes in the strategic environment that is always dynamic, and related to organizational aspects.

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1. INTRODUCTION

The vast territory of the Unitary State of the Republic of Indonesia and the existence of ALKI as an international trade route, as well as the presence of regional military alliance forces, namely the Five Great Powers (FPDA) and AUKUS (Australia, Great Britain and the United States) are a great potential to allow violations of national airspace, including the entry of unidentified aircraft or commonly called black flights with certain purposes and the possibility of causing losses that endanger the sovereignty of the Unitary State of the Republic of Indonesia which will commit these violations in 2023. 1,421 airspace violations (1,130 Lasa X) and until the first quarter of 2024, as many as 400 violations (186 of which are Lasa X). This Lasa X is an unidentified aircraft identified by the national air defense system.

The procedure for identifying Lasa X in the national air defense system is carried out through a mechanism within the Air Defense Integrated System (ADIS). ADIS is a system that combines sensors, command and

control, and execution. This process begins with an initial stage where an unknown aircraft is detected by military radar, then continues to the identification stage using a flight plan and Flight Clearance Information System (FCIS), which is derived from data that has been entered into the air situation data transmission system. This system is also equipped with data from the Military Civil Coordination (MCC) and processes up to the action stage, where one of the available options is destruction by order of the President during peacetime situations.

According to the mechanism for recognizing and conveying information gradually to the leadership for decision-making in issuing action orders, it is currently still not running optimally [1]. This is due to the length of time or bureaucracy that occurs from the detection stage until the decision is made, with a time span varying from 30 minutes to more than 1 hour [2]. This time span is influenced by the completeness of the data and the speed in coordinating and confirming information. One of the steps in ADIS is the recognition of type X, which is currently carried out in various ways, including: First, electronic identification based on flight data (flight plans) that have been automatically integrated in the command and control data integration system (C2). Second, correlational identification is carried out by an Identification Officer (PA Ident) on duty at the Kosekhanudnas Posek by aligning flight plan information and FCIS, monitoring communication channels between the aircraft and ATC, coordinating with the MCC, and confirming flight data with intelligence agencies. Third, the visual recognition process is carried out by interceptor aircraft if the first and second methods are unable to identify an unknown aircraft. The recognition process in all three methods requires quite a long time [3]. This could pose a threat to the sovereignty of the Republic of Indonesia, making the presence of Lasa X, or the unidentified aircraft, ultimately undetectable [4]. This lengthy timeframe is due to the identification process, which relies on data previously entered according to the flight plan and FCIS. Furthermore, coordination is required to confirm with the MCC and intelligence staff any information not yet included in the flight plan. Furthermore, there is a multi-level reporting process from the PA Identifier to the President.

The alternative is to utilize existing technological advances, such as artificial intelligence and Industry 4.0 (including cyber-based warfare) [5]. This can be applied to improve the ADIS system by addressing issues related to identification time and the authority decision-making process in managing the Lasa network (Network Centric Warfare or NCW) and can be applied as a solution to overcome various existing problems. This statement is in line with what was conveyed by the Chief of Staff of the Air Force (KASAU) at the first press conference, where he emphasized his commitment to making the Indonesian Air Force a formidable air force by achieving air superiority through the implementation of network-centric strategies. war. (NCW).

The use of AI can be used as an alternative to existing identification methods, through electronic, correlative, or visual means, including replacing the tasks and roles of PA Ident [6]. The ability of artificial intelligence to verify and calculate data will save time in determining Lasa X, as well as reduce the risk of errors, resulting in more accurate results [7]. This is proven when the operating method and workflow of AI can be designed according to the desired needs. This process uses a computer processor as a data processor capable of processing high-speed information related to flight data such as flight plans, FCIS, aircraft movement and position, and can even determine the type of "aircraft".

The application of NCW in ADIS development will produce higher-quality information that will improve decision-making [8]. This will ultimately achieve air superiority in carrying out military operational missions under the NCW pyramid concept [9]. The speed of a manager's decision-making process can be increased by the presence of information

processed by AI and then distributed to relevant leaders. Furthermore, the information received can be received in real time, allowing for more accurate decisions regarding what actions to take on Lasa X.

The combination of AI and NCW applications will enable more effective decision-making in determining the type of aircraft used for direct action. This is based on the results of the AI identification of the type of Lasa X aircraft, as well as the selection of interceptor aircraft with capabilities at least equivalent to the Lasa X aircraft. In this way, the success of the mission can be guaranteed. In addition, information about the selected aircraft will be displayed simultaneously in the air squadron and through a special application on the handheld device of the official who gives approval or decision regarding the action by the interceptor, thanks to integration in the NCW network.

The current development of AI and NCW studies has been widely applied in the defense sector. Previous research emphasized the crucial role of mastering artificial intelligence technology in supporting military activities [10]. In a study conducted by [11], it was explained that the application of artificial intelligence (AI) in aircraft functions for system management, monitoring, and aircraft diagnostics. Meanwhile, [12] suggested that AI can improve capabilities related to the importance of estimating the launch time of missiles used in air defense systems. Another study related to NCW Sokolvic discussed the application of the internet of things (IoT) in a military context, which has had a significant impact overall. This research provides an overview of the use of NCW in the military field, particularly in improving the ability to predict, control, and make decisions. Based on recent technological advances, it is understood that the application of artificial intelligence (AI) in various fields, especially in the Indonesian National Armed Forces (TNI), is generally focused on providing information related to applications aimed at replacing existing systems and improving capabilities compared to previous situations. However, until now, there has been no research that utilizes artificial intelligence as a tool to increase speed and accuracy in the ADIS system that functions to identify unknown aircraft, or what is known as lasa X. This research also aims to determine the type of lasa X aircraft and to identify the type of interceptor aircraft that has a minimum balanced capability, to ensure mission success in national air defense operations. This situation creates an opportunity to carry out more in-depth research.

Based on the background and references from the state of the art, related to AI and NCW, and the condition of the phenomena of the existing problems, as well as the gaps from previous research, research is needed with the output in the form of implementing AI combined with NCW on ADIS in order to realize a Resilient air defense with the outcome of intact Indonesian sovereignty and being respected in the region and globally.

2. RESEARCH METHODS

This research quasi-qualitative method uses a phenomenological approach and a deductive-inductive thinking style as well as a post-positivist paradigm. This study provides solutions by analyzing ADIS development strategies using several approaches, namely: First, Soft Systems Methodology (SSM) is the main method supported by the analytical hierarchy method (AHP) used as a method to identify decisions through pairwise comparisons between selection criteria and pairwise comparisons between available alternatives. This method is the main tool to support the study that aims to answer research questions related to the selection of the most appropriate strategy for preparing and developing AI-based ADIS, in accordance with the driving forces faced by the country.

3. RESULTS AND DISCUSSION

3.1. Overview of ADIS Indonesia's Capabilities

Air defense systems are deployed to support the task of maintaining national sovereignty in

airspace. Generally, an air defense system is a combination of a network of electronic warning systems and military strategies designed to safeguard a country from the threat of missile attacks or strategic bombers. Air defense systems utilize radar and satellite technology to monitor a country's airspace. This provides information that helps human rights defenders identify such attacks and collaborate in responding to them. Koopsudnas is tasked with directing integrated defense efforts in the nation's airspace, both independently and in collaboration with other TNI Operations Commanders. These actions are carried out to realize the sovereignty, unity, and other interests of the Unitary State of the Republic of Indonesia. These actions are carried out in collaboration between TNI elements and civil society organizations with competence in the air defense sector.

A country's air defense is carried out through the operation and integration of various air defense components. These components include air bases, radar systems, fighter aircraft, missiles, warships, passive air defense, air defense artillery, and military-civilian collaboration (MCC) using civilian radar. The main strength of the Radar weapons system (Alutsista) owned by Koopsudnas currently consists of 20 Radar Units with a total of 21 Radar units. However, there are still areas that are not covered (blind spots/areas). Thus, in line with the strategic plan for developing the strength of the Indonesian Air Force for the period 2020-2024, it is planned to procure 34 new Radars which are very important to meet the current Radar needs of the National Air Operations Command (TNI AU Strategic Plan 2020-2024).

The air defense concept implemented by Koopsudnas aims to prevent, deter, and address various forms of aerial threats from the outset. Within the operational area of the air defense system, Koopsudnas implements a strategy known as Defense In Depth, a multi-layered air defense system. The goal of this approach is to achieve superiority and control in the airspace, thereby preventing airborne threats that could potentially endanger national safety and sovereignty (Kohanudnas 2017 Standard Operating Procedure).

This operation is intended to ensure the creation of safe conditions in the airspace and national air force bases, without the risk of violence, navigation violations, and violations of the law in the airspace, including violations of prohibited and restricted airspace defense identification zones or airspace. Air Defense Identification Zone (ADIS), violations of airspace in the Indonesian Archipelago Sea Lane (ALKI) and the threat of space objects entering the earth's orbit heading towards Indonesia, as well as several areas in the form of airports that are used together, air force bases are joint airports, air force bases are in border areas, areas with potential risks.

3.2. Impact of ADIS Capabilities on Air Defense Threats

Each type of threat has distinct characteristics. These characteristics relate to several elements, including: level of difficulty, methods used, target categories, vulnerable targets, exploitation patterns, attack complexity, scenario selection, and the impact of the damage [13]. In terms of risk, attacks on Obvitnas assets in the defense and military

sectors are considered to have a significant impact on the survival of a nation and state. These include the armed forces that oversee them.

Figure 1. ALKI Map

There are several areas in Indonesia that, from an air defense perspective, are considered to be at relatively high risk. For example, consider the presence of ALKI I, II, and III, which serve as unscheduled flight routes. Aircraft passing through these routes do not need to obtain prior permission from the Ministry of Defense, the Ministry of Foreign Affairs, or the Ministry of Transportation. They simply report their altitude and other parameters upon entering the area. In fact, these ALKI routes are very close to vital national assets. If an aircraft were to fly over ALKI and suddenly attack a nearby vital object, the fighter jets tasked with responding to the threat would be slowed down and unable to respond quickly.

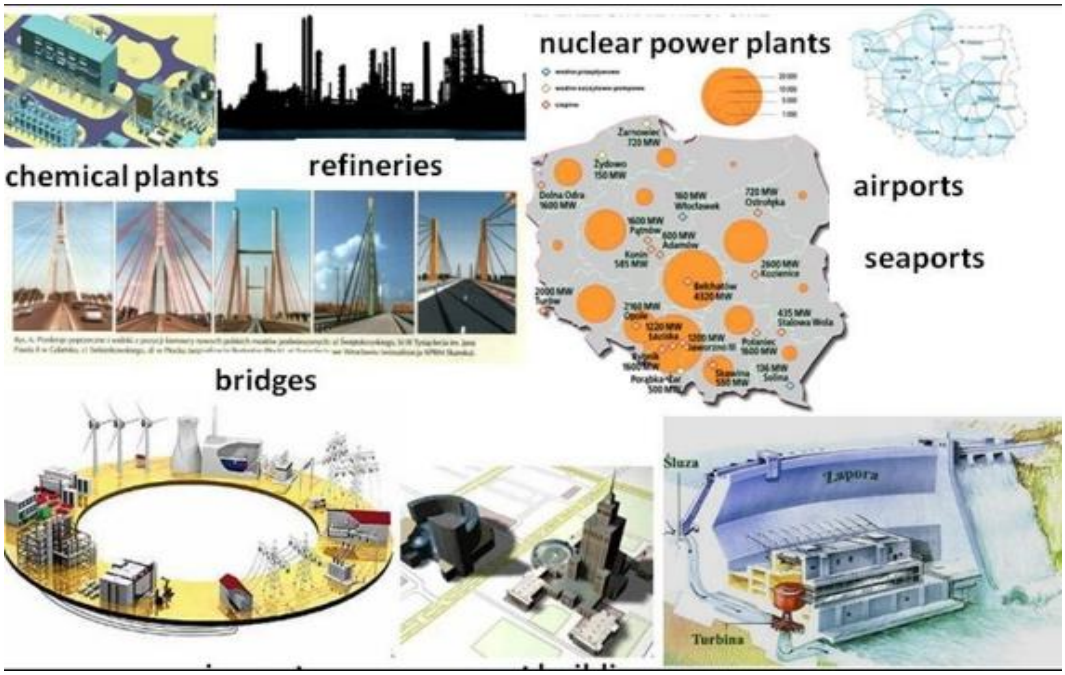


Figure 2. Targets of Air Threats to National Vital Objects

The violations involving US aircraft over Bawean and helicopters flying over the Palace demonstrate the vulnerability of Indonesia's national defense system. The sequence of events involving Bawean and the helicopter over the Palace can be summarized as follows: imagine if such aircraft were capable of flying over key national locations and even launching attacks, the nation's sovereignty would be immediately shaken. Various strategic national assets that could affect government stability and harm public interests include administrative centers, economic centers, airports, reservoirs, and various other infrastructure.

3.3. Implementation of AI in the National Air Defense System

Technological development is dynamic and constantly changing. Many technologies can be used to simplify tasks in ways previously unimaginable. Artificial Intelligence (AI) and machine learning are part of the future of technology, with applications in various fields, including radar technology in the National Air Defense System (Sishanudnas). AI is a technology that integrates human intelligence into machine devices. This is done by devices running a series of algorithms to solve problems in completing a task.

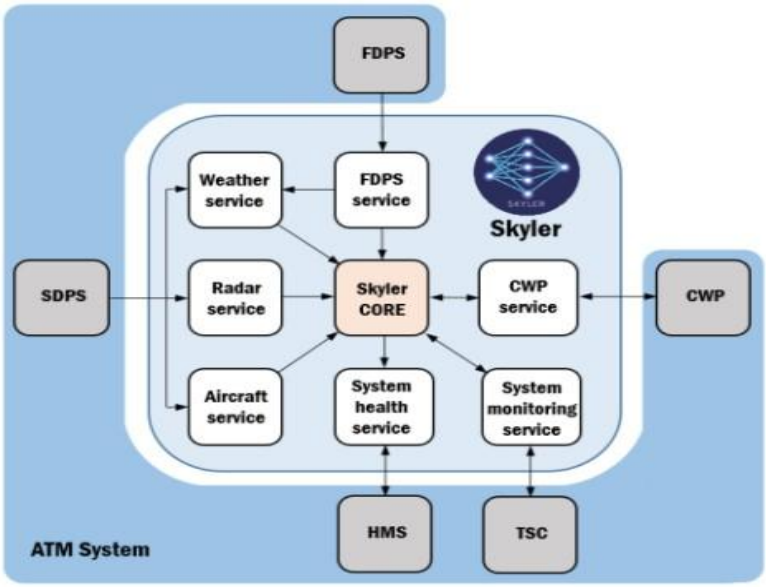


Figure 3. Artificially Intelligent Air Defense Agent

Artificially Intelligent Air Defense Agent will be able to provide intelligent assistance to Air Defense Controllers regarding various targets and information contained in the With Artificial Intelligence capabilities, it will be able to assist Air Defense Controllers in carrying out their operations for Air Defense. Based on the effectiveness of the use of the AI and ML systems mentioned above, the application of ML in Sishanudnas is applied to Radar technology, where the data captured by Radar in Satrad, which is integrated in Posek and Popunas can be optimized.

The use of AI in the context of radar technology or surveillance monitoring is the application of Machine Learning (ML) technology. ML is used to illustrate methods used to solve various real-world challenges by utilizing computer systems through a learning process.

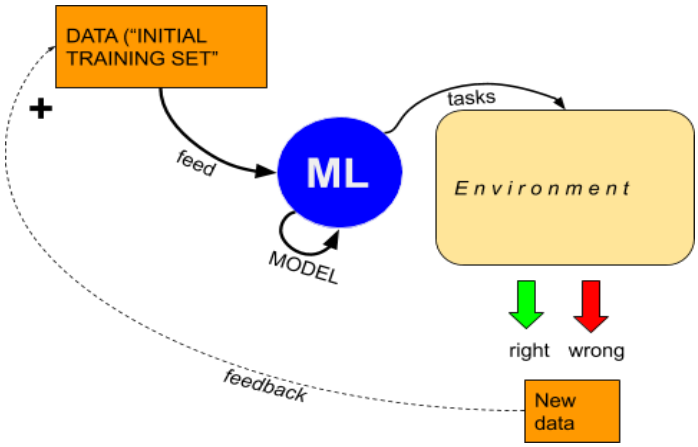


Figure 4. Artificial Intelligence Working System

The basic principle of ML is to use given data, known as a "training set," to build a model. This model typically consists of decisions, choices, and strategies, which are then used to solve various tasks automatically without human intervention. The feedback generated from this process depends on the reactions that occur and can produce various types of results, such as "true" or "false," or a decimal value derived from a feature vector. This feedback, combined with information from the context in which the ML is applied, can be combined with existing data to form a new dataset, which can then be used to develop new models, and so on.

3.4. Strategy for Developing a Robust Artificial Intelligence-Based National Air Defense System

Not all five strategic domains can be developed simultaneously. In a political context, there will generally be a gradual process in their development. To determine the sequence of components, this study used the AHP method. The figure below shows the decision-making structure using the AHP method in question. In the implementation stage.

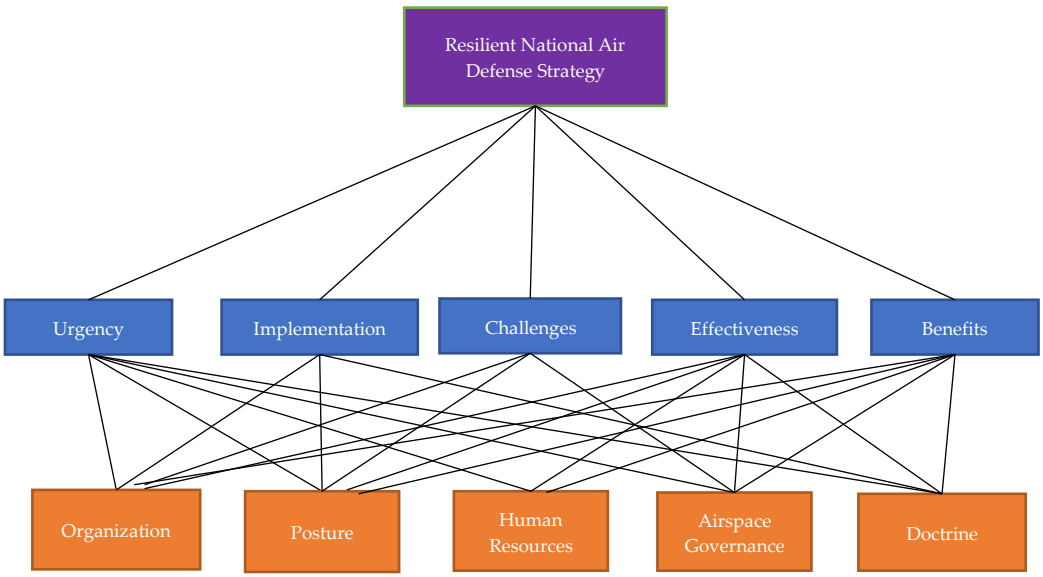


Figure 5. AHP Structure

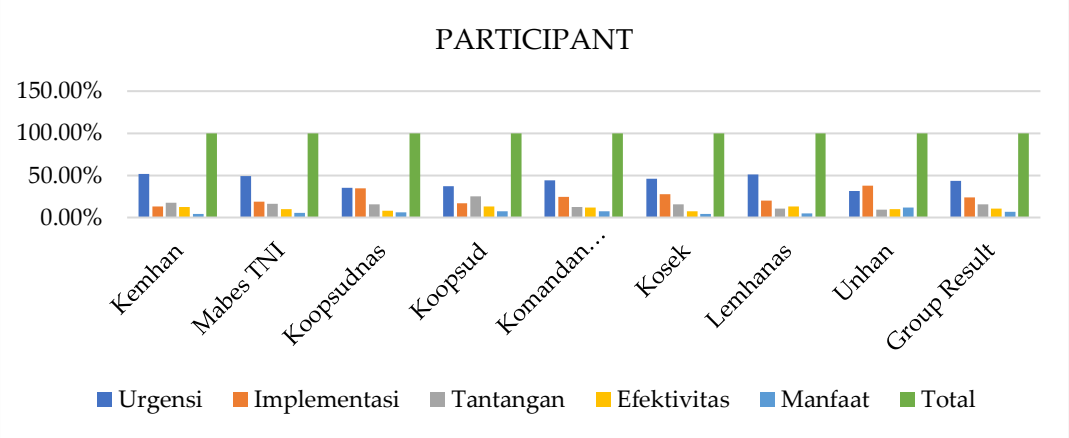
The primary objective of this activity is to prioritize the development strategy for a robust AI-based Sishanudnas (National Air and Air Force) system. Five strategic development domains will be identified for their importance: Doctrine Development Strategy, Sishanudnas Posture, System Integration, Human Resources (HR), and Airspace Governance. To establish these priorities, five main criteria were identified as a reference.

Urgency: the level of importance of having a relevant strategy in the present, where air threats appear in various places; Implementation: ease in designing and implementing the points of aspects described in the strategy; Constraints: the magnitude of the challenges or problems faced in compiling and developing various aspects of the Sishanudnas strategy; Effectiveness: the possibility of success in implementing the strategy in accordance with the expected goals and objectives; and Benefits: related to the positive impact or value felt by the state, society, and stakeholders from the strategy domain that has been compiled.

The evaluation results from eleven respondents showed strong agreement. The weightings shared among the criteria were: Urgency (43.26%), Implementation (24.13%), Challenges (15.44%), Effectiveness (10.71%), and Benefits (6.46%).

Table 1. AHP Data Processing Results: Main Criteria

	Urgency	Implementation	Challenge	Effectiveness	Benefit
Ministry of Defense	52.00%	13.10%	17.80%	12.70%	4.40%
TNI Headquarters	49.10%	18.80%	16.50%	10.20%	5.30%
Koopsudnas	35.10%	34.80%	15.90%	7.80%	6.40%
Koopsud	37.10%	17.20%	25.10%	13.10%	7.60%
Unit Commander	44.10%	24.20%	12.70%	11.70%	7.30%
Doormat	45.90%	27.50%	15.50%	7.10%	4.00%
National Resilience Institute	51.30%	19.80%	10.80%	13.10%	5.00%
Defense University	31.50%	37.60%	9.20%	10.00%	11.70%
Group Result	43.26%	24.13%	15.44%	10.71%	6.46%



Overall, all the strategic needs described above must be viewed within the framework of a comprehensive air defense system. This encompasses aspects ranging from Sishanudnas posture, human resources, airspace management, doctrine, and organization, as well as

how all assets can be integrated in the implementation of air defense operations. Human resources, the individuals involved in the Sishanudnas ecosystem, are vital assets that carry out Sishanudnas operations. A human resource-based approach is needed in Sishanudnas development to achieve effectiveness and efficiency. Carry out air defense operations.

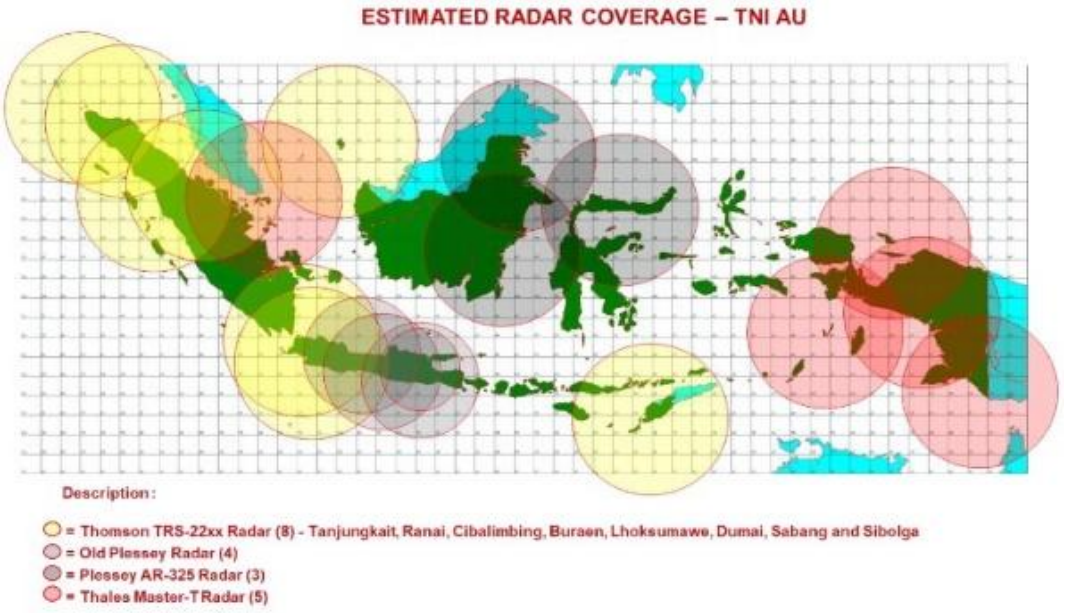


Figure 6. Air Defense Surveillance System Integration

Airspace Management. Indonesia's vast national airspace requires effective management involving various stakeholders to achieve the nation's interests, including safeguarding state sovereignty in space. What is the context of doctrine? Does it relate to law, religion, or other aspects? As an operational policy, there are things that need to be considered for revision if an opportunity arises. These changes include re-understanding and/or revising the country's territorial boundaries, not just limited to land, water, and airspace, but also encompassing outer space and cyberspace.

4. CLOSING

4.1. Conclusion

Risks in the air sector can disrupt a country's sovereignty, particularly those related to the right to airspace, national integrity, citizen protection, and state security. The following are some risks that can pose dangers: (i) attacks on the country's critical infrastructure that can disrupt the operation of vital systems related to people's lives, such as government institutions, defense facilities, and the provision of electricity, water, energy, and transportation; (ii) violations of airspace that not only threaten national sovereignty but can also pose risks to flight safety; (iii) aerial espionage activities through surveillance that can uncover various covert activities and operations in the defense and military sectors, both those already carried out and those being planned; (iv) cyber threats that can cause technology-based air defense systems to malfunction and even potentially take over control of military systems.

Currently, Indonesia's air defense system still requires

comprehensive strengthening. Several incidents that threatened airspace in the past have revealed that Indonesia's geography and airspace management, particularly those related to ADIS and ALKI issues, are highly vulnerable to various aerial threats. The impact of limited strength and capabilities, as well as the unbalanced distribution of Sishanudnas' defense equipment, has resulted in gaps in radar coverage and delayed response from fighter jets in dealing with emerging air threats. This situation illustrates that our current national air defense system is not yet able to function optimally to confront or mitigate any threats that arise in the country's airspace.

4.2. Suggestion

Indonesia must develop a strong, robust, independent and sovereign air defense ecosystem model, in accordance with the structure and characteristics of the Indonesian nation as an archipelagic nation. The ecosystem that is built cannot be separated from the Indonesian air defense field which consists of 11 main elements that are interconnected, namely: (i) effective, efficient and responsive arrangement or management to rapid change; providing: (ii) quality Sishanudnas infrastructure that covers the entire territory of the Republic of Indonesia; (iii) workers who have skills, abilities and in-depth knowledge in the field of air defense; (iv) computer technology, hardware and software (applications) that operate to maintain airspace; (v) budget allocated for the development of a sustainable air defense system; (vi) defense industry supporting national interests; (vii) coordination between the military and civilian sectors in airspace management; (viii) political support and various government organizations in efforts to realize a strong, independent and sovereign air defense system; (ix) the participation of the community and Hanud community in efforts to protect the airspace of the Republic of Indonesia; (x) strategic contribution of universities to the creation of human resources, science and various innovative products through research and development; and (xi) the role of the media, particularly in public awareness and understanding of air defense issues.

The proposed strategy for strengthening air defense includes the establishment of a National Air Defense System Posture (Sishanudnas) and AI-based system integration. This encompasses efforts to improve human resources (HR) quality, along with efficient airspace management, principles that adapt to technological advancements and the ever-changing strategic environment, and organizational aspects.

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